Digitizers for LARIAT

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Sometimes you get lucky

- End of FY2013 presented us with an unexpected opportunity

  - Some $$$ available to invest in the FTBF infrastructure

  - Long term usefulness, not 100% LARIAT specific

  - PO needed quickly

- ADF-2 digitizers limit readout rate

  - Let's replace them

Basic parameters

- Drift time ~ 350 us for L=0.5m

- Sample at 400ns granularity (2.5 MHz)

- Cover whole drift time + a bit

  - 400ns/sample/channel * 1000 samples/event
    = 400us/channel/event

- 12 bit ADC → ~2 bytes/sample

 - 2000 bytes/channel/event

- 500 chan * 2kB /chan/event = 1MB/event

Basic parameters

- ~100 events/spill = 100 MB/spill
- Two extremes:
  - continuously readout at 25 MB/sec on average
  - buffer whole spill, readout at end
- Both options possible in the systems we considered.
  - Second is more conservative
- The system must be able to serve the future program

Few choices

- Easy to buy a few channel digitizer which runs at 100-1000MHz and above

- We want many channels (~500) with slow digitization (2-5 MHz)

- We want them delivered by end Dec

- We want to limit engineering and dev cost.

- CAEN is essentially the only vendor

Candidate systems - V1740C
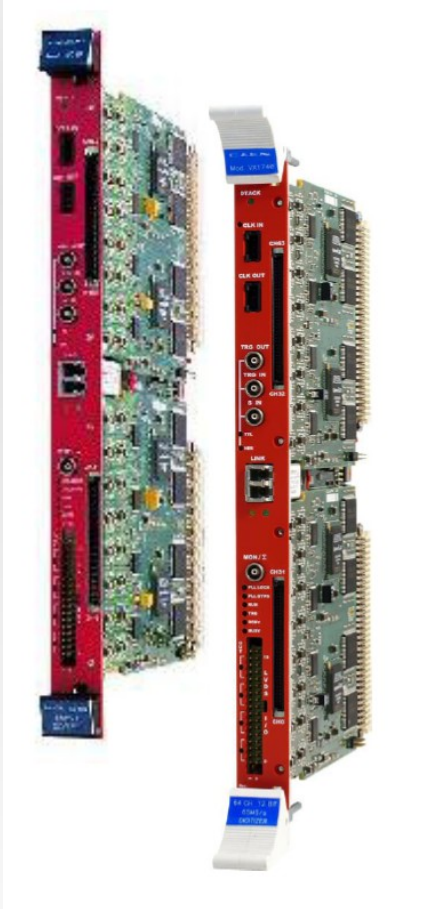
- VME digitizer with added optical readout to PCIe

- 64 Channels / module !

- 62.5 MHz sampling rate
  - 16ns granularity

- 12 bit ADC, 2V range

- 192 kS/ch buffer

- 80 MB/s readout / module
  - Experience suggests less

Candidate systems - SY2791

- 32 ch/module
- 256 ch per 4U crate
- Optical readout to PCIe
- 80 MB/s / module
- Used in a few LAr TPCs around the world

- 40 kHz - 2.5 MHz sampling rate
- 12 bit, 3.3V range
- 16kS/ch buffer
  - upgrade to 128kS/chan

Decision criteria

V1740C

- The sampling rate is too fast
  - need down-sampling before buffering
- Are VME ops needed?
  - VME just needed for power?

SY2791

- How many of these systems exist?
- How quick to produce?
- Can we get a loaner to do DAQ development?

And, of course, price

Feedback from CAEN

V1740C

- The sampling rate is too fast
  - Downsampling firmware by Dec
  - Done before buffering
- VME ops needed?
  - No. VME crates only for power.

SY2791

- Relatively few have been built.
  - less SW and HW experience
- Have not produced the upgraded memory version.
- No loaner available

Proposed base system

- Eight V1740C
  - 8 x $9700 = $77,600
- Two PCIe readout cards with 4 optical links each
  - 2x $3800 = $7600
- 5m optical cables = 8 x $100 = $800
- Total: $86,000

Infrastructure reuse

- Existing VME crates for power
  - some power supply swaps needed
  - need good cooling
- Need 1 or 2 readout PCs
  - Will reuse existing if possible
- ArtDAQ framework already knows some CAEN modules

Possible extensions

- 100ft optical cables would allow the DAQ to be located in the counting house

- Deeper (1.5 Ms/chan) buffers?

  - 8 x $1300 = $10,400

- 1 spare module = $9,700

- 1 CAEN crate = $7,000

  - Useful for V1495. Where does PMT digitizer sit? Do we need another optical link? Do we need a crate controller?

Timeline

- Final decisions today/tomorrow/weekend
- PO needs to be in next week
- CAEN confirms delivery by end-December
  - Smaller loaner system on a short timescale